ON THE

VERTEBROID HOMOLOGIES OF THE CRANIUM IN VERTEBRALIA OR OSTEOZOA,

AND THE

ANALOGOUS HOMOLOGIES OF THE ANNULOZOA OR ARTICULATA.

WITH TABLE.

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SYNONYMS OF THE CRANIAL HOMOLOGIES IN FISHES.

Macdonald.		Owen.	Huxley.		Bertrand.	Cuv.
I. OCCIPITAL BIVERTEBRA.						
1. Basi-occipital	⊕					
2. Atlo-occipital	P					
3. Lamella-occipital	L					
4. Spina-occipital	T					
II. OTIC BIVERTEBRA.						
5. Basi-otic	⊕	1. Basi-occipital	BO	Basi-occipital	1. Basilaire	5.
AXOID.						
6. Hypotic	P	2. Ex-occipital	EO	Ex-occipital	2. Ex-occipital	10.
7. Mammilla and Epi-otic	*		EP	Epi-otic	4. Par-occipital	9.
	L	4. Par-occipital				
8. Wormi-otic	T	3. Snr-occipital	SO	Supra-occipital		
ATLOID.						
9. Pro-otic	P	16. Petrosal	PM	Petro-mastoid	7. Rocher	13.
10. Mastoid	*	8. Mastoid	M	Mastoid	9. Mastoid	12.
11. Parietal	L	7. Parietal	Pa	Parietal	10. Parietal	7.
III. SPHENOID BIVERTEBRA.						
12. (AX) Basi-sphenoid (Olivare) and Rostrum	⊕	5. Basi-sphenoid 9. Pre-sphenoid	BS	Basi-sphenoid	5. Post-sphenoid	6. 5.
13. Orbital	P					
14. Anterior clinoids	*					
15. Ingrasial wings	LT					
16. (AT) Ali-sphenoid	P*L	6. Ali-sphenoid			6. Ali-sphenoid	11.
17. Orbito-sphenoid	T	10. Orbito-sphenoid	OS	Orbito-sphenoid	20. Orbito-sphenoid	14.
IV. ETHMO-FRONTAL BIVERTEBRA.						
18. Basi-ethmoid	⊕		Eth	Ethmoid Lam. perpend.	19. Pre-sphenoid	5.
(AX) Nasal-spine and Promontory		15. Nasal				
19. Ethmoid plate					20. Orbito-sphenoid (?)	14.
20. Turbinal (upper)	PL	14. Prefrontal 19. Turbinal (?)			15. Ethmoid	2.
21. (AT) Superciliary ridge	P					
22. External angular	*				15. Ethmoid (?)	2.
23. Frontal	L	11. Frontal	F	Frontal	21. Frontal	1.
V. APOCRANIAL BIVERTEBRA.						
24. Ossa-nasi	L					
25. Lachrymal and Planum	P					
26. (AX) Nasal cartilage	⊕					20.
CRANIAL PROVERTEBRAL LAMINÆ.						
24. 25. 26. 27. 1st *Hæmarc.* Naso-rhiual Alar cartilages in Man		15. Nasal			43. Nasal	3.
						17.
28. 2d *Hæmarc.* Pre-mandible	P	22. Pre-maxilla			41. Vomer	16.
29. * Incisive palate	*L	13. Vomer				18.
30. 3d *Hæmarc.* Mandible	P	21. Maxilla				
31. 32. Alveola and Palate	*L	20. Palatine (?)				
33. 34. 4th *Hæmarc.* Post-mandible palate	P *					
35. Horizontal palate (toothless)	L					
36. 5th *Hæmarc.* Ex. pterygoid	P					
37. 6th *Hæmarc.* Int. pterygoid	P					
TRACHELOKIST OF THE SPLANCHNO-SKELON.						
38. Epiglottis		42. Glosso-hyal				41.
39. Hyoid body	⊟	41. Basi-hyal				39. 40.
40. Cricoid						42.
41. Thyroid		43. Uro-hyal				38.
42. Large omo-hyoid	LT	40. Cerato-hyal				37.
43. Tuber lamellæ	*	39. Epi-hyal				29.
44. Styloid	P	38. Stylo-hyal				43.
45. Brauchiostegal rays		44. Branchiostegal				
LIMB ZONES AND THEIR LIMBS.						
PROTHORACIC, OR TEMPORAL ZONE.						
46. 47. Glenoid	L T	26. Meso-tympanic (?) 27. Pre-tympanic		Symplectic		31. 27.
48. Zygoma (fishes)	T	12. Post-frontal				4.
49. Condyle maxillæ ,,	P	28. Hypo-tympanic				26.
50. Articulo-coronoid ,,	L	29. Articular				
51. Tuber lamellæ ,,	*	30. Angular				
52. Deutal ,,	LS	31. Splenial 32. Dental				
MESOTHORACIC, OR HUMERAL ZONE.						
53. Scapula	P	25. Epi-tympanic				23.
54. Clavicle	LT	34. Pre-opercle				30.
55. Brachium	P	35. Opercle				28.
56. Cubit	*L	36. Sub-opercle				32.
57. Carpo-digital	T	37. Inter-opercle				33.
METATHORACIC, OR COXAL ZONE.						
58. Ilio-pubic (humau)	LT	50. Supra-scapula				46.
59. Femur	P	51. Scapula				47.
60. Patella	*	52. Coracoid				48.
61. Tibia	L	58. Epi-coracoid				49.
62. Fibula						50.
63. Astragalis (tarsus)						52.
64. Calcaneum ,,		54. Ulna				51.
65. Navicular ,,		55. Radius				64.
66. Cubo-cuneiform ,,		56. Carpus				65.
67. Metatarso-digital ,,		57. Metacarpal phlanges				

ON THE

VERTEBROID HOMOLOGIES OF THE CRANIUM IN VERTEBRALIA OR OSTEOZOA, &c.

Ever since the promulgation of the grand and independent inspirations of Goethe and Oken on viewing the bleached cranium of a deer or sheep in the Black Forest, which impressed them with the resemblance the cranium bore to a series of vertebræ more or less fused together, the theory of a unity of organisation, traceable throughout all the vertebrate and articulate classes, has been wrought out downwards to the lowest Eozoa or Acrita. The main object of this communication is to point out the homologies which appear in the human cranium, as the first part of the subject, and especially, to determine the true homologies of the different types from man to the lowest ichthyia or osseous fishes, and afterwards those analogous homologies of Scleroderms among the Annulozoa and Arthrozoa (the Articulata.—Cuv.)

A few changes in the usual terms of the anatomical school will be required for the clear elucidation of this important subject. *Skelon* will be substituted for Endoskeleton, and the different segments will be styled Skelotomes. Instead of Exoskeleton or Scleroderm, *Scleron* will be used, and Sclerotome for any segment seen in the Arthrozoa and Annulozoa. *Somatome* will include a segment of both *skelon* and *scleron*, together with the visceral or *splanchnoskelon*, and the soft parts connected with them. These terms are slightly modified from those proposed by Professor Goodsir.

The characteristic difference distinguishing the VERTEBRALIA from all other members of the zoological scale is drawn from the existence of a central stem or *kaulon*, usually styled the Spinal or Vertebral column. I restrict this term to the stem formed by the centra or bodies of the vertebræ continued through the basicranium, having sometimes a mesospine on its ventral aspect. On its dorsal aspect, the perineural tunnel protecting the myelon or spinal marrow, is formed by the coalescence of the neur-arcs on each side, firmly anchylosed to the individual skelotome of the kaulon, and extending backward to unite in the neural spine.

These Neur-arcs are formed of three distinct parts, like all other laminæ—

1. The *Pediele* fused into the vertebræ, and forming part of the aperture for transmitting the spinal nerves (*trous des conjugaison*).

2. The *Lamella*, generally the largest part, with the tubercle and flat portion extending downwards and backwards in man, and, at the junction with its fellow of the other side, gives support to the neural spine. On the edges of the lamella the articulating surfaces, allowing a slight motion, are met with. The extension of the epiphysis of the tubercle has been described *incorrectly* as the transverse process, as it is only connected with the centrum or vertebra by means of the pedicle.

3. The *Neural Spine* is formed by the extension of the lamella meeting in a spine. Restricting the term *Vertebra* to the *centrum*, the neur-arcs form the *metavertebræ*, while the laminæ developed on the ventral aspect converging to the sternum form the *provertebræ*. These are constructed on the same plan as the neur-arcs, and may be called *Hæm-arcs*, as enclosing the trunk and main branches of the vascular system.

The Hæm-arcs also consist of three parts—

(1.) Pedicle, or head and neck of the rib, normally articulated opposite the intervertebral space, partly on each of the adjoining vertebræ, and protecting the trunk of the spinal nerve issuing from the neural tunnel beneath it.

(2.) The lamella or body of the rib; its tubercle rests on that of the neur-arc of the next lower vertebra.

(3.) The spine or cartilage of the true ribs is attached to the sternum, where it exists, or coalesces in the median line.

It may also be assumed that there exists a *provertebral stem* or *prokaulon* as exhibited in the sternum of mammals, birds, and reptiles, which Geoffroy St Hilaire termed *Sternebræ*, as well as *metakaulon*, or *dorsibræ*, represented in the interspinous bones of ichthyia or osseous fishes.

The splanchno-skelon, represented by the hyo-branchiostegal and branchial system, belongs to the prokaulon or provertebral system, which includes the prothoracic, mesothoracic, and metathoracic wings of the insect and the ventral fins of fishes.

The provertebral trunk of mammals consists of there kistæ or thoraces.

I. Prothorax or prosopo-kista includes the bones of the face or mandible.

(i.) Rhinal or prenasal arcs.
(ii.) Incisive or premandibular arcs.
(iii.) Mandibular arcs.
(iv.) Palatal or postmandibular arcs.
(v.) External pterygoid arcs.
(vi.) Internal pterygoid arcs.
(vii.) The velum or soft palate.

The hard palate, like the carapace of the crustacea, is formed by the union of ii., iii., and iv. hæmarcs.

II. Mesothorax or pneumo-kista is formed by the ribs meeting in the sternum or prokaulon, enclosing the hyo-branchial splanchno-skelon.

III. Metathorax, or aidoio-kista, supports the hypogastric and pelvic viscera.

Encircling these there are three limb zones or girdles, each having a pair of members or limbs articulated to them.

I. The temporal zone, formed by the squama-temporis—zygoma and malar bone firmly binding the procranium and metacranium over the mesocranium. In the glenoid cavity the head of the maxilla or condyle is articulated, forming

the 1st laminar portion or pedicle; 2d, the angle or tubercle and base of the maxilla—lamella; and, 3d, the mentum or incisive portion or spine.

II. The humeral zone or scapulo-clavicular.

From the glenoid cavity.

1*st*, The brachium or pedicle depends;

2*d*, The antibrachium or forearm;

3*d*, The carpo-digital completes the lamina.

III. The Coxal Zone or Pelvis.

1. The femur is articulated in the acetabulum.
2. The tibia and fibula form the lamella, but in this case the tarsus and toes may be viewed as a repetitive member.
   (1.) The astragalus.
   (2.) The calcaneum and navicular.
   (3.) The toes.

Perhaps the same arrangement should be adopted with the carpo-digital.

After these preliminaries we may proceed to the analysis of the cranium, placed on the summit of the *kaulon*, where the first and second cervical vertebræ have a different relation to one another from what is seen in the lower vertebræ: in order to give the extended motion enjoyed by the human cranium equivalent to the universal joint, the body of the axis, with its narrow lamellar tubercle and very prominent spine, has a strong odontoid process developed on the upper surface of the centrum, which intrudes, and in a manner replaces a large part of the body of the atlas, here reduced to a mere bony ring having a meso-spine on its ventral surface, while the axis is retained by a strong ligament behind it, completing the floor of the neural tunnel. The posterior ring of the atlas has the lamellar tubercles or transverse processes much produced, but the neural spines very small, greatly contrasting the axis in all particulars.

The axo-atloid relation is carried out in the basicranium, where each centrum has a double perineural arch in the following ascending order:—

Bivertebræ.		Metavertebræ.
I. Basi-occipital.	⊕	*P.* Condyloid. *L.* Edge of Foramen magnum. *S.* Sub-occipital spine.
II. Basi-otic.	⊕	*Axoid.* *P.* Hyp-otic and Mammilla. *L.* Epi-otic. *S.* Wormi-otic. *Atloid.* *P.* Pro-otic and Mastoid. *L.* Parietal.
III. Basi-sphenoid.	⊕	*Atloid.* Alæ majores—Orbito-sphenoid. *Axoid.* Olivare. *P.* Optic. *L.* Ant. clinoid. Alæ Ingrassii.
IV. Ethmo-frontal.	⊕	*Atloid.* *P.* Supra-orbital plate and Supercili-ary ridge. *L.* Os frontis. *Axoid.* Ethmoid and turbinals.
V. Apocranial.	⊕	Nasal protuberance and Ossa nasi.

The relation of these vertebroid skelotomes of the cranium to the encephalon and the cranial nerves is very important, and deserves more notice than can be given in this hasty communication to the Royal Physical Society. Had time permitted, the vertebral analogies could be shown by the intervertebral transmission over the pedicle. This part of the subject, with the evidence afforded by development in the fœtus, will form the subject of a future communication.

Without attempting to examine fully the course of development of the human cranium, a slight sketch is necessary to show the coincidence between the fœtal and adult condition.

Professor Huxley has assumed that there are three states or conditions of the human fœtal cranium.

I. The membranous or vesicular cranium, when the skelon is entirely membranous, consisting of investing tissue enclosing the centrochord (noto-chord) between the neural and hæmo-splanchnic axes, which consists of mere cellular substance within a structureless sheath, forming a primitive centre around which the bodies of the vertebræ are so placed as to afford a floor or basement for the cephalo-myelon to rest upon, over which the neur-arcs raise an arched tunnel by the anchylosis of the neural spinous process of each meta-vertebral skelotome in adult condition.

II. The chondro-cranium, shortly after fœtal development has commenced, may be traced, at several points, around

both the cephalic and spinal centroehord in the cartilaginous square masses observable on each side, and which appear to be the tubercles of the neur-ares, whieh are first ossified, and from whenee ossification of the pedicle extends to the centrum vertebræ, and in the other direetion eompletes the lamella, and ultimately terminates the spinous proeesses. In the basi-cranium a similar proeess may be observed around the foramen magnum and onward.

III. The Osteo-cranium, commeneing with the basieranial axis, in the same order as when describing the ehondroskelon.

(i.) The *Occipital Bivertebra* begins to show points of ossifieation before they appear in the vertebral kaulon. At birth the oeeipital bone eonsists of separate pieees: 1. Basilar; 2. Condyloid; 3. The eerebellar fossæ, formed in membrane about the same time that the wormi-otie spine appears in two points. The different parts of the oeeipital bivertebra are not eompletely ossified before the sixth year.

(ii.) The *Basi-otic Bivertebra*:—The eentrum 5 is formed by the anterior part of the basilar process (*posterior clinoids*), which is subsequently so ineorporated with both the basioceipital and sphenoid, that Sœmmering described them as a single bone *spheno-occipital or basilar* in the adult eondition of the eranium. The petrous is early developed, and besides forming the hyp-otic 6 and 9 the pro-otie, eontains the otic capsule. The ossifieation begins in these in a ehondrous state, about the same time as the ossifieation of the kaulon. The parietals are ossified in membrane.

(iii.) The *Axo-prespheno Bivertebra, or the Anterior Spheno-orbital* (Beelard) ossifies very early in fœtal life, at the margin of the foramen opticum, and extends along the ingrasial wings 18. These are afterwards united in the eentre. Towards the close of fœtal life this vertebra is elosely united with the sphenoid, and is usually in Anthropotomy deseribed as part of that bone.

The *Atlo-sphenoid* centrum 12 with the rostrum 12′, and the pedicles of the wings, are ossified in cartilage, but the ala major results from membrane. The ossifieation begins in

the sphenoid soon after the occipital, and is developed from many centres. Beelard divided these into two elasses:— 1. The posterior or spheno-temporal ineludes the ala major 16, where the first nuclei are seen anterior to the foramen rotundum, from whence the ossification extends outwards and upwards into the alæ majores, and downwards into the pterygoids 36, 37. About the same time there are two ossifie points for the eentrum 12, and the lateral projeetion, as described by Meckel, and copied in "Quain's Anatomy" (fig. 26, b. 5).

(iv.) The *Ethmo-frontal Bivertebra.*—The perpendieular plate of the ethmoid extends through the atlo-frontal, arising from the frontal protuberanee, and forming the axoid portion. The ossification of the frontals or the atloid portion eommenees early in membrane, by a central point in eaeh half. They are separate till birth, and in females often remain so during life.

(v.) The *Apo-cranial Bivertebra* is formed by the nasal promontory 22, with the nasal spine continued into the septum nasi (24) axoid.

The atloid consists of nasal 23, eartilage 24, rhinal 25.

Before eoneluding this hasty communieation, the attention may be directed to prepared disarticulated erania of the eod, as representing the osseous fishes.

I. That by Mr Flower of London, aeeording to the views of Professor Owen.

II. That prepared by Mr Davies, of the Natural History Museum, Edinburgh, aecording to the system advocated in this paper.

It will be seen that in the No. I. Professor Owen has omitted the oeeipital vertebra altogether, having mistaken it for the atlas, but as it eloses in the par-eneephalie or cerebellar eavity, as shown in No. II. in its proper relation with the distinet cranio-vertebral charaeters. This, of course, renders the numbers used by Professor Owen ineorreet, as may be seen by referring to the tables where the names adopted in this paper are so arranged as to show the synonyms of Owen, Huxley, Bertrand, and the Nos. of

Cuvier, where the homologous bones, according to the different authors, can be identified. (See Table, p. 49.)

On the Thoracic Zones and Limbs of Osseous Fishes.

The temporal zone 46–48 inclusive, and its limb, is attached to the anterior margin of the scapula 53, described as the *tympano-mandibular arch* (Owen); the scapula or epitympanic (Owen)—the suspensorium (Huxley)—supporting the opercular bones of fishes.

The *temporal* of Cuvier will be found to represent the *mammal temporal* as well as the *scapula*, advanced and articulated with the mastoid (10). It is more varied in its shape, and, besides the *coracoid* and *glenoid* processes for the union with the *clavicle* (54) and the *brachium* (55), it projects another forward to support the *temporal* 46, 47, and the *condyle maxillæ* (49), all connected by squamous suture.

Professor Owen has hazarded a wilder homology in regard to the pectoral fin of the ichthyologist. In this he follows Cuvier, who, in the subject of homology, was perhaps the worst guide who could be taken, as by his eloquence and influence in the Institute having defeated the brilliant Geoffroy St. Hilaire on his fanciful homology of the opercular apparatus, he was inclined to repudiate homology altogether.

Cuvier, misled by the idea that the pectoral fin was the homologue of the anterior extremity, fancied that the coxal zone 58 was the *supra-scapula*, and the *femur* 59 was the *scapula*, thus including two distinct and separate portions of the skelon in the construction of one bone, while in one of the bones of the leg the *tibia* 61, has to represent two bones.

The most objectionable part of the homologies of Owen, Cuvier, Huxley, &c. &c., is the confusion caused by including in fishes the scapulo-clavicular or humeral zone with the arm as bones of the cranium, merely from their being in close connection with it, instead of being placed lower down the trunk, as in mammals.

I. The Pro-thoracic or Temporal Zone 46, 47, 48, is mis-

named as in connection with the tympanum as well as 49, which will be found to be the condyloid part of the maxilla, which is completed by 50, 51, and 52.

II. The Mesothoracic or Humeral Zone 53. The scapula is also included in the tympanic series, and supports 54, 55, 56, 57 the opercular bones of Owen, and the bones of the internal ear, according to Geoffroy St Hilaire, but which will be found anatomically to be homologues of the scapulo-clavicular zone, and anterior or respiratory limb of mammals—the skelon of the *Lophius piscatorius* shows this by having the fin rays developed, though not protruding through the skin.

III. The Metathoracic or Coxal Zone. Cuvier and the continental comparative anatomists have here entirely misled Huxley, Owen and his followers, by describing the pectoral fin of the ichthyologists as the supra-scapula, the scapula, arm, and hand, whereas 58 is the coxal or pelvic zone, and from 59 to 67—the thigh, leg, tarsus, and toes. This must be cleared up before any system of homology can be correctly assigned between the ichthyic and mammal types. The first approach is made in the chondrous skelon of the rays, where opercular bones are in relation to their proper function, as the arm, supported on the scapulo clavicular zone, having the hand greatly enlarged—in fact, forming the large portion of the body of the skate—while the pectoral fin is supported by the coxal or pelvic zone near the commencement of the tail, as the claspers in the male.

The crowding of the limbs about the cranium of fishes has been pre-typified in the invertebral Annulo-zoa and Arthro-zoa, which are neurapods, from having their legs and feet so bent as to appear on the neural aspect; the osteo-zoa are hæmapods, from having their feet and legs on the ventral or hæmal aspect.

The insects and crustacea, with their neural axis or myelon below both the visceral and hæmal axes, may be said to walk on their back, and have all the thoracic rings closely placed at the head, the œsophagus passing through the neural ganglia representing the brain, in its way to the oral opening, which, in all non-sessile animals, opens towards the

ground on which they walk. In both these classes the oral apparatus consists principally of the early representatives of the cranial metavertebral neur-arcs.

The Antennæ	=	VI. The Apocranio-Nasal.
The Labrum	=	V. Frontal.
The Mandible	=	IV. The Sphenoid Alæ.
The Maxilla with its palpi	=	III. The Parietal.
The Labium	=	II. The Wormi-otic.
The Mentum	=	I. The Occipital.

These represent the metavertebral neur-arcs.

The invertebrate scleron has neither a central kaulon, nor the metavertabral nor provertebral pedicles; but the provertebral lamellæ and spines meet over the dorsal vessel or hæmaxis, resting its tubercle on that of the metavertebral lamellæ, whose spines are united under the neuraxis.

The prothoracic or temporal zone supports the prototype of the vertebrate maxilla.

The mesothoracic ring supports the arms, and represents the humeral zone, which, in insects, carries on the hæmal upturned aspect, the first pair of wings, appendages of the respiratory organs, whether lungs, branchiæ, tracheæ, &c. &c.

The metathoracic ring supports the hind legs, and the second pair of wings on the hæmal aspect, representing the ventral fins in fishes.

In crustacea the number of legs from the mesothoracic and metathoracic rings are doubled; the provertebral carapace homologous with the mammal palate completely covers the centres of the nervous, digestive, and vascular systems; these rings are incomplete.

A portion of Professor Huxley's "Lectures on the Vertebrate Skeleton" has appeared in "The Lancet," illustrated by diagrams in wood. These have been little consulted, from being inconsistent with the vertebral scope of this paper, based on the unity of organisation and the vertebroid homologies of the animal kingdom. "Who can decide when doctors disagree?"

On Development as the basis of Homology.

Agassiz, Goodsir, Huxley, and others, maintain that the

study of the progressive development of the various laminæ composing the skelon is the only basis on which the determination of aecurate homology can surely rest; and Cuvier long ago propounded the same dogma when enumerating the bones in eaeh speeies of the mammalia. "We must descend to the primitive osseous centres as they exist in the fœtus." Owen showed the inapplieability of this rule, as the human brachium should be counted three bones instead of one, and in like manner four would be enumerated instead of the femur. The Cuvierian rule fails by not distinguishing between the ossific points whieh permanently complete the bone and those whieh only typify parts of bones which are in the fœtal condition separate, in order to facilitate ossifieation of individual bone, as the cases above referred to. The study of development having eomparatively but a restricted sphere among anatomists and naturalists, little advantage can safely be taken of it, as in the present state of our knowledge it seems to have led as mueh to confusion as to elear views. It is safer to examine the progress of ossifieation in the adult species, as seen in the animal scale.

Keeping in view the simple scheme of the foregoing eommunication where the term "vertebra" is restrieted to the kaulon or central stem of the vertebral column and the peri-neural or meta-vertebral portion of the segment, restricted to the neur-ares of the tunnel of the cerebro-spinal axis and the peri-splanehnic and hemal or pro-vertebral part of the segment, and instead of the eomplex apophysal terms of Owen using the eommon terms of the medical schools of anatomy for the elemental component parts of the laminæ, whether simple as in the ribs and maxilla or lower jaw, or in those more complex laminæ of the limbs,—where the earpus and tarsus seem to be the repetition of the laminæ, braneling from the distal joint of the lamella or second part.

The vertebrate skelon eonsists of a central chain of bones in its early condition, diseoid in form, enveloped in a membranous tissue forming the centro-ehord as exhibited in the Lancelet,—(*Amphioxus lanceolatus*—*Branchiostoma*—Owen). This lowest vertebrate type was classed as an inver-

tebrate annelid till it was shown by Goodsir (Roy. Soe. Edin. Transactions, xv. 1), and Owen (in his Lectures, ii. p. 171), to possess a feeble median linear eentro-ehord arrangement; most distinet anteriorly, where it is eylindrical, it is continued to the very point of the animal, beyond the early development of the olfactory and optie nerves, the first dawn in vertebralia of the Mes-eneephalon and Pros-eneephalon, and aceompanied by the trigeminal nerves from the Par-eneephalon or upper part of the Myelon. The centro-chord supporting the neural axis and placed above the visceral and hemal axes, instead of lying below as in the invertebralia, places the Laneelet in a higher relation than its former associates—the Entozoa.

The centro-chord, though not the spinal column, is admitted to be at least the nucleus of the chain of vertebral centres, which has been reeeived as proving the vertebral condition of the eranium, first propounded by Goethe, Oken, Spix, Dumeril, and others; and since their day, in this country, by Grant, Owen and a host of his followers, and not disputed till lately by Huxley, in his leetures to the Royal College of Surgeons, first reported as they were delivered, but without his revisal, in "The Laneet," and now being published in the "Medical Times," arranged and corrected by himself. One object of the talented Professor seems to be the repudiation of the Goethe-Oken vertebrate theory of the eranium. Their brilliant inspiration, if it were no farther tenable than giving a good and clear orderly sequence of arrangement of the multitudinous collection of variously shaped bones, could have been profitably used by Professor Huxley in rendering his excellent lectures moro lueid, and thus adding another tribute to the illustrious Germans above named, while he eould have introduced the later discoveries of Rathke, Reichart, Hallman, and his own, with more advantage to the farther advancement of this very important theory.

It is much to be regretted that he did not follow up the vertebral argument more eompletely. There are some parts of the subject where development would be useful in the establishment of homology, still it is not always to be de-

pended upon. Nor are we always to expect that those bones which appear in the mature cranium as single may not arise from more than one ossific centre. Owen has remarked the danger of development multiplying the number of bones by the number that appeared in the fœtal condition of the mammal, or in the lower skeleton of the fishes.

The temporal bone, anthropotomically described, is a marked instance of this, and consists of a vast number not only of osseous elements but distinct members of the skelon. The human temporal zone supporting the maxilla, or lower jaw, is formed by the squamous plate and zygoma, as far back as the middle of the glenoid cavity, bounded by the glasserian fissure, all the rest of the bone being connected with the basi-otic vertebra—the pro-otic or petrous bone forming the pedicle of the petro-parietal neur-arc, having the mastoid process as the tuber lamellæ, while the hyp-otic, extending outwards to the digastric mammilla is the tuber lamellæ of the wormi-otic neur-arc. The interval between these is filled up by auditory or otic sense capsule, containing the labyrinth or internal ear, with the tympanum and vaginal process, in which the styloid is inserted ; this very complex bone, though single in human anatomy, contains no less than part of two vertebral neur-arcs, and the auditory apparatus, in addition to the temporal limb zone ; at the same time forming the barrier between the cerebral and cerebellar cavities.

Fully impressed as we are with the importance of the study of development in determining the homologies of the skeleton, it may be doubted whether a sufficient acquaintance with it has yet been acquired to enable us to trust to it as the only sure guide. An erroneous theory of fœtal development cannot be expected to correct a mistaken homology, however supported by names distinguished in science.

Without presuming to maintain that the homology here sketched will be received in all its details, it may be fearlessly maintained that no sound homology in fishes can be sustained, without adopting some of the suggestions of the foregoing communication, especially as regards the opercular bones and pectoral fins in fishes—in regard to which

Cuvier, St Hilaire, Owen, Huxley, &c. &c., have completely misapprehended the homology—in the study of a rather complex subject, while, at the same time, it allows the fullest scope for speculative interpretation of the laws of organic development.

It is generally admitted that the vertebral column is developed on the *Chorda centralis*, but that the first traces of ossification in the embryo are the square bodies seen on each side of the linear groove of the *Blastoderm*, " which eventually become the middle region of the head or mesocranium, and the *dorsal laminæ* produced, extending forwards or backwards like parapets on each side of the primitive groove, and lay the foundations of the lateral walls not only of the skull but of the spinal column. Very early the boundary between the skull and spinal column is laid down. The proto-vertebral elements increase in number from the mesocranium *backwards* throughout the whole length of the spinal column, and *forwards* to the tip of the cartilage of the nose."

" The dorsal laminæ first coalesce in the middle cephalic region, extending forwards and backwards. The cephalic canal is separated into three distinct dilatations or cerebral vesicles, of which the anterior is the largest." Subsequent flexure of the vesicles divides the cavity of the cranium into pro-cranium and meso-cranium, at angles to each other; as development proceeds the meta-cranium and para-cranium cover the posterior lobes of the brain and cerebellum. The neur-arc forming the chondroid tunnel of the cerebrum and cerebellum, from the posterior occipital through the wormian and masto-parietal, coalesce with the ethno-frontal, and cover the ali-sphenoid and spheno-orbital. The basi-cranium, composed of, (1.) basi-occipital; (2.) basi-otic, or basilar; (3.) basi-sphenoid, or basi-olivare; from the *rostrum sphenoidis* the chondroid plate of the ethmoid and nasal is prolonged. This chondroid condition is well seen in the cranium of the Salmonidæ, where the osseous frontal and parietal are easily forced off the cartilage, and the long basi-sphenoid is equally removable from the chondroid basi-cranium, which extends into the incisor or pre-mandibular palate, sometimes misnamed the vomer. Agassiz main-

tained that the centro-chord did not extend beyond the *sella turcica ;* and Huxley seems to adopt the same opinion, though, strangely enough, he admits that in the Lancelet it extends to the utmost length of the animal, beyond the termination of the myel-encephalon. It may be as well to remind the student that the relation of neuraxis and the hæmaxis to the digestive or intestinal tube is completely different in the articulate and vertebrate classes. In the segment of the crustacean and entomoid classes, the neuraxis is contained in a small canal below formed by the neur-arcs, but without any kaulon or central stem, and lies beneath the digestive or intestinal canal. The anterior or oral termination, passing through œsophageal nervous ring, being the type of the par-encephalon behind with the auditory apparatus, while the mesencephalon and prosencephalon, with the optic and olfactory sense capsules, lie before. Thus the pharynx and mouth of the invertebral pass where the pituitary body and infundibulum (possibly the typical remnants of the mouth of the invertebrals), occupy the sella turcica, the ethmo-frontal forming the labrum, the sphenoid and presphenoid the mandible, the parietal and wormi-otic the maxilla, and the occipital the labium. The hæmaxis runs along the upper part of the segment above the visceral cavity.

In the vertebrate classes, the relation of these axes is inverted. The neuraxis, above the intestinal tube, which is no longer found to pass through a ring in the neuraxis after the vertebral kaulon has been interposed, and the hæmaxis in the visceral cavity on the ventral aspect.

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